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STAFF REPORT

1980 PESTICIDE USE ON FIELD CORN
IN THE LAKE STATES

by

Michael Hanthorn, Craig Osteen,
Robert McDowell, and Larry Roberson

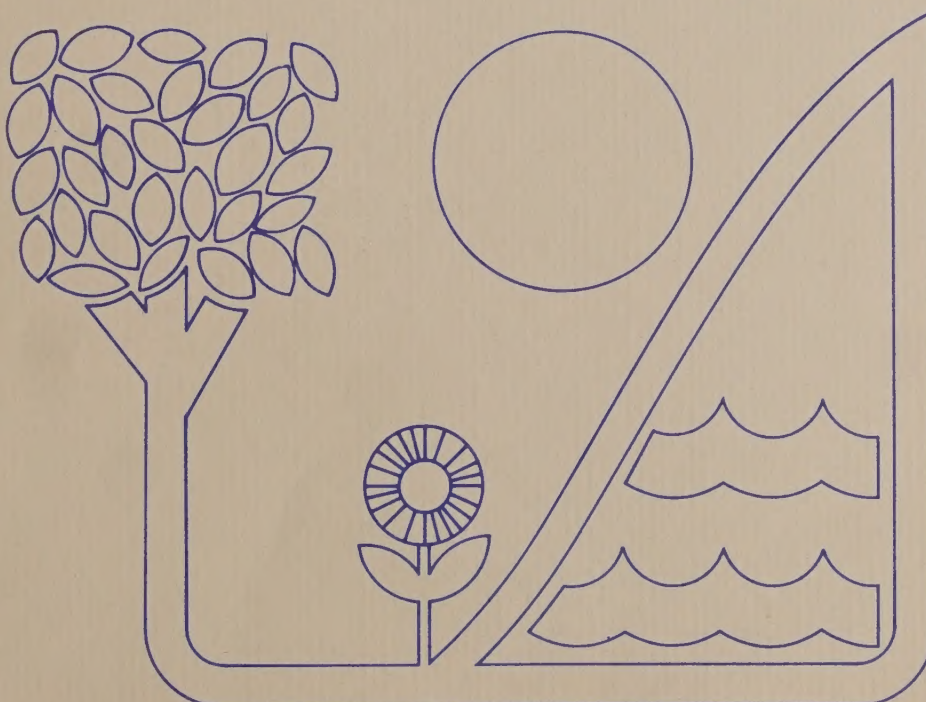
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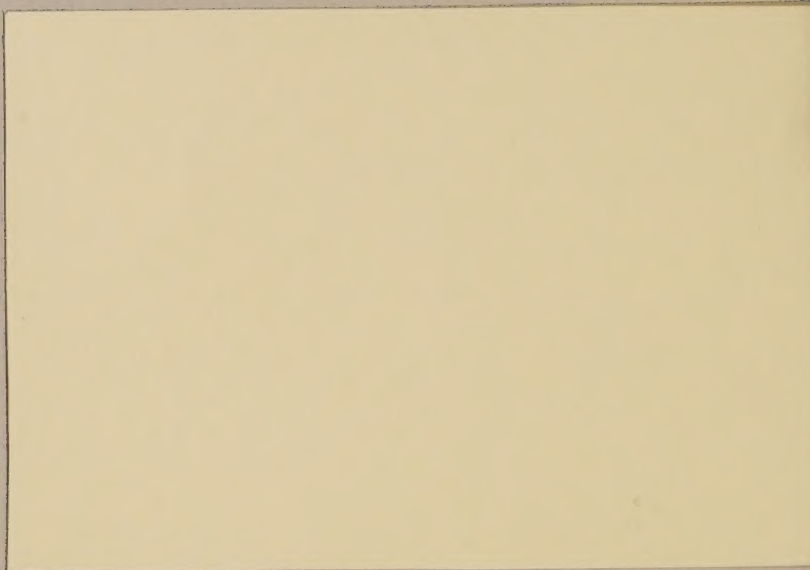
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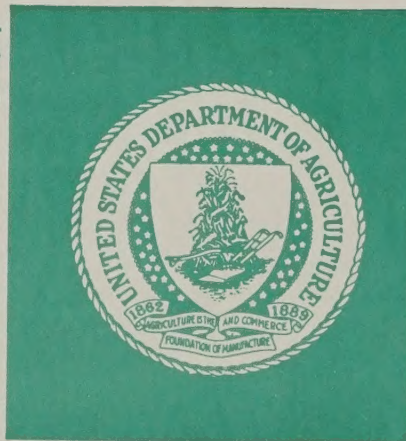




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ABSTRACT

farmers reported that 99.3 million pounds of pesticides were applied to field corn in the Lake States in 1980. The total value of pesticides applied was \$14.7 million. The most commonly used pesticides were herbicides, insecticides, and fungicides. The most common pests controlled were weeds, insects, and diseases.

1980 PESTICIDE USE ON FIELD CORN
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Michael Hanthorn, Craig Osteen,
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Key words: Pesticides, field corn, Lake States, 1980, survey, herbicides, insecticides, fungicides, weeds, insects, diseases, primary target pests, field corn, and Lake States.

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Natural Resource Economics Division
Economic Research Service
U.S. Department of Agriculture
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ABSTRACT

Farmers reported that 49.3 million pounds (a.i.) of pesticides were applied to field corn in the Lake States during 1980. This consisted of 43.4 million pounds (a.i.) of herbicides and 5.9 million pounds (a.i.) of insecticides. Pesticide acre-treatments totaled 26.3 million and consisted of 16 million with single material herbicides, 4.7 million with herbicide mixes, and 5.6 million with insecticides. The primary herbicides were alachlor, atrazine, cyanazine, and 2,4-D. The major insecticides were carbofuran, fonofos, phorate, and terbufos. Herbicides were applied primarily to control cocklebur, foxtail, and quackgrass infestations. Most insecticides were applied for corn rootworm larvae control. Coefficients of variation were computed for acres of field corn treated with specific pesticide materials.

Key words: Pesticides, herbicides, insecticides, active ingredient, acres treated, acre-treatments, application rates, primary target pests, field corn, and Lake States.

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* This paper was prepared for limited distribution to the research community outside the U.S. Department of Agriculture. Use of product names in this report is for identification only, and does not imply endorsement by the U.S. Department of Agriculture. *

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The 1980 Corn Pesticide Use Survey was conducted by the Statistics Division of the Economics and Statistics Service. Herman W. Delvo provided guidance and made valuable suggestions during this effort. The report was reviewed by Rod Coan, Stanford Fertig, Armand Padula, Peter Rich, and Michael Stellmacher. A special thanks is extended to Andrea Lunsford for typing the preliminary and final manuscript drafts.

AUTHORS

Hanthorn, Osteen, and McDowell are with the Economic Research Service. Roberson is with the Statistical Reporting Service.

PREFACE

This report presents data for pesticides applied to field corn in the Lake States during 1980. Pesticide use data for the major producing States not included in the Lake States and for all major producing regions are available in the following ERS Staff Reports:

- "1980 Pesticide Use on Field Corn in the Corn Belt"
- "1980 Pesticide Use on Field Corn in the Northern Plains"
- "1980 Pesticide Use on Field Corn in the Major Producing States".

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INTRODUCTION

This report presents pesticide use data for field corn grown in the Lake States during 1980. The data include usage patterns and quantities of specific herbicides and insecticides applied to field corn. This information should be useful to policymakers, academic institutions, government agencies, and private and commercial entities in evaluating the impacts of regulatory actions on specific pesticides, conducting economic analyses of pesticide use, developing more effective pest management programs, and conducting pesticide market analyses.

METHODOLOGY AND TERMINOLOGY

The Economics and Statistics Service collected pesticide use data as part of the 1980 Corn Objective Yield Survey. A total of 2,870 farmers were personally interviewed by enumerators in the 16 major field corn producing States, of which 515 were located in the Lake States. The sample size by State was as follows: Michigan, 120; Minnesota, 210; and Wisconsin, 185.

Sample fields for each State were randomly selected from farmers who reported through the June Enumerative Survey that they had planted or intended to plant field corn in 1980. Each field corn acre in a State had an equal probability of being selected. Consequently, the probability of a field being chosen was directly correlated to its size.

Several terms pertinent to this report are defined as follows. An "active ingredient" (a.i.) is that portion of a pesticide material that provides the control activity. "Acres treated" are the number of acres receiving one or more applications of a specific pesticide during the growing season. Acres treated with different pesticide materials cannot be summed because more than one material may have been applied on a given acre during the growing season.

Therefore, the addition of these numbers would result in multiple counting. "Acre-treatments" are the number of acres treated with a pesticide material multiplied by the number of applications made during the growing season. Acre-treatments are summed for each material at the State and regional level. "Pesticide mixes" are two or more pesticide materials that are premixed during formulation or tank-mixed at the time of application.

Pesticide application rates vary as a result of weather conditions, soil type, weed spectrum, and insect species. Also, the method of application influences the amount of a material used per acre. Herbicide and foliar insecticide application rates are generally expressed as broadcast rates. The amount of a material applied on an acre in either a band, in-furrow, or spot application is generally one-fourth to one-third the amount applied in a broadcast application. The application rate listed for each material in this report is an aggregation of band, broadcast, in-furrow, and spot applications.

RELIABILITY OF ESTIMATES

Estimates based upon sample surveys have varying degrees of statistical reliability. Confidence in data depends upon sample size, sampling methods, and the variability of the responses. To provide the user of the data with some indication of the reliability of the estimates, coefficients of variation (CV's) are presented in Appendix Table 1. The CV is a measure of relative variation (expressed in percentage terms) and can be used to indicate the degree of confidence a user can place in the estimate. The smaller the CV, the more reliable the estimate.

In simplest terms, it can be said there is 95 percent confidence that the sample represents the true population and that the true value for the population lies within an interval defined as the estimated value ± 2 CV's times the

estimated value. For example, with a CV of 10 percent and an estimate of 40, the interval would be 32 to 48. However, there is also a 5 percent chance that the true value does not fall within the interval as defined above because the sample is not representative of the population.

CV's were calculated only for acres treated with specific pesticides. The estimates of acres treated are expected to have greater variation than other data reported. Consequently, for most other information included in this report, the level of reliability should be equal to or greater than reported for acres treated.

LAKE STATES

Description

The Lake States include Michigan, Minnesota, and Wisconsin (Figure 1). During the 1980 growing season, 17 percent of the acreage planted to field corn (14.4 million acres) in the United States was located in this region, from which 18 percent of the corn for grain (1.2 billion bushels) and 22 percent of the corn silage (24.5 million tons) were produced (Table 1). The farm value of corn for grain grown in the Lake States during 1980 was \$3.7 billion.

Trends in Pesticide Use

Between 1972 and 1980, acres planted to field corn increased from 10.8 to 14.4 million (Table 2). Acres treated with herbicides, which nearly doubled during this period, totaled 13.7 million in 1980. This amount represented 95 percent of the regional planted acreage. Acres treated with insecticides nearly tripled from 2 to 5.7 million during this period, and represented 40 percent of the planted acreage in 1980.

The largest percentage increases in herbicide and insecticide treated acreage occurred in Wisconsin and Michigan, respectively. In general, herbicide

Table 1. Field corn acreage planted and harvested, production, and value in the Lake States, 1980

| States | : Total acres a/ | | | : Total production a/ | | : Value |
|------------|---------------------|---------|----------|-----------------------|----------|-----------------|
| | : Harvested | | | Bushels | Tons of | : of |
| | : Planted | : Grain | : Silage | : of grain | : silage | : grain b/ |
| | ----- Million ----- | | | | | Million dollars |
| Michigan | 3.0 | 2.6 | 0.3 | 247 | 4.4 | 790 |
| Minnesota | 7.2 | 6.3 | .9 | 610 | 10.6 | 1,861 |
| Wisconsin | 4.2 | 3.3 | .8 | 348 | 9.5 | 1,080 |
| Region | 14.4 | 12.2 | 2.0 | 1,205 | 24.5 | 3,731 |
| U.S. total | 84.1 | 73.1 | 9.3 | 6,648 | 111.1 | 21,687 |
| Percent of | | | | | | |
| U.S. total | 17 | 17 | 22 | 18 | 22 | 17 |

a/ "Crop Production-1980 Annual Summary", USDA, ESS, Crop Reporting Board, CrPr 2-1(81), January 14, 1981.

b/ "Field Crops-Production, Disposition, Value 1979-80", USDA, ESS, Crop Reporting Board, CrPr 1(81), April 1981.

Table 2. Field corn acreage planted and treated for weed and insect control in the Lake States, 1972 and 1980

| States | Planted | | Treated acres | | | | Percent of planted acres treated | | | |
|-----------|----------------|---------|---------------|---------|--------------|---------|----------------------------------|------|--------------|------|
| | acres | | Herbicides | | Insecticides | | Herbicides | | Insecticides | |
| | 1972 a/ | 1980 b/ | 1972 c/ | 1980 d/ | 1972 c/ | 1980 d/ | 1972: | 1980 | 1972 : | 1980 |
| | <u>Million</u> | | | | | | <u>Percent</u> | | | |
| Michigan | 2.1 | 3.0 | 1.5 | 2.8 | 0.04 | 1.4 | 69 | 93 | 2 | 48 |
| Minnesota | 5.6 | 7.2 | 4.2 | 6.9 | 1.0 | 1.7 | 74 | 95 | 18 | 24 |
| Wisconsin | 3.1 | 4.2 | 2.0 | 4.0 | .9 | 2.6 | 65 | 96 | 31 | 62 |
| Region | 10.8 | 14.4 | 7.7 | 13.7 | 2.0 | 5.7 | 70 | 95 | 18 | 40 |

a/ "Agricultural Statistics, 1974", U.S. Department of Agriculture.

b/ "Crop Production-1980 Annual Summary", USDA, ESS, Crop Reporting Board, CrPr 2-1(81), January 14, 1981.

c/ Herman W. Delvo, "1972 Corn Objective Yield Survey", USDA, ERS, Farm Production Economics Division, 1972, (unpublished).

d/ "1980 Corn Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

use, as measured by the percent of planted acres treated, was similar in the Lake States during 1980, whereas insecticide use varied substantially. One-fourth of the planted acres in Minnesota were treated with insecticides, while 62 percent were treated in Wisconsin.

Pesticide Use

The major field corn weed and insect pests, as reported by farmers in the Lake States, are listed in Tables 3 and 4. Although several pests may have been present at any given time and caused varying degrees of damage, farmers were asked to report what they perceived to be the primary target pest for each material applied to field corn. In 1980, farmers reported that cocklebur, foxtail, and quackgrass were the primary target pests for 11, 28, and 27 percent of the herbicide acre-treatments, respectively (Table 3). Corn rootworm larvae were the major target pest for 92 percent of the insecticide acre-treatments (Table 4).

Approximately 49.3 million pounds (a.i.) of pesticides were applied to field corn in the Lake States during 1980 (Table 5). This amount consisted of 28.2 million pounds (a.i.) of single material herbicides, 15.1 million pounds (a.i.) of herbicide mixes, and 5.9 million pounds (a.i.) of insecticides. Application rates for herbicides, applied alone and in mixes, were 1.8 and 3.2 pounds (a.i.) per acre-treatment, respectively. Insecticide applications averaged 1.1 pounds (a.i.) per acre-treatment.

About 26.3 million pesticide acre-treatments were made on field corn, of which 16 million were made with single material herbicides, 4.7 million with herbicide mixes, and 5.6 million with insecticides.

Alachlor and atrazine acre-treatments totaled 3.6 and 4.5 million, respectively, and accounted for 50 percent of the single material herbicide acre-treatments. Cyanazine, dicamba, and 2,4-D acre-treatments totaled

Table 3. Percentage of field corn herbicide acre-treatments by primary weeds controlled as reported by farmers in the Lake States, 1980 a/

| Pests | : | : | : | : |
|------------------------|---------------------|-------------|-------------|----------|
| | : Michigan | : Minnesota | : Wisconsin | : Region |
| | ----- Percent ----- | | | |
| <u>Grasses</u> | | | | |
| Broadleaf signalgrass | 2 | 1 | 1 | 2 |
| Crabgrass | 5 | 1 | 1 | 1 |
| Foxtail | 13 | 37 | 19 | 28 |
| Panicum | 2 | - | 2 | 1 |
| Quackgrass | 48 | 13 | 42 | 27 |
| Other | 8 | 5 | 7 | 5 |
| <u>Broadleaf weeds</u> | | | | |
| Canada thistle | - | 8 | 1 | 5 |
| Cocklebur | 2 | 17 | 2 | 11 |
| Morningglory | 1 | 1 | 1 | 1 |
| Pigweed | 9 | 5 | 1 | 5 |
| Ragweed | 6 | 4 | 3 | 4 |
| Velvetleaf | 1 | 3 | 18 | 6 |
| Other | 3 | 5 | 2 | 4 |

- None reported.

a/ "1980 Corn Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

Table 4. Percentage of field corn insecticide acre-treatments by primary insects controlled as reported by farmers in the Lake States, 1980 a/

| Insects | : | : | : | : |
|----------------------|----------------|-------------|-------------|----------|
| | : Michigan | : Minnesota | : Wisconsin | : Region |
| | <u>Percent</u> | | | |
| Corn rootworm larvae | 92 | 90 | 92 | 92 |
| Cutworm | 2 | - | 1 | 1 |
| European corn borer | 6 | 8 | 3 | 5 |
| Wireworm | - | 2 | 1 | 1 |
| Other | - | - | 3 | 1 |

- None reported.

a/ "1980 Corn Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

Table 5. Usage patterns and quantities of specific pesticides applied to field corn in the Lake States, 1980 a/

| Pesticides | : Acres b/ | : Acre- c/ | : Pounds of active ingredient | |
|----------------------------------|------------|---------------|-------------------------------|-----------------|
| | : treated | : treatments: | Total | : Per treatment |
| ----- <u>Thousand</u> ----- | | | | |
| HERBICIDES | | | | |
| <u>Single materials</u> | | | | |
| Alachlor | 3,574 | 3,574 | 8,614 | 2.4 |
| Atrazine | 4,341 | 4,471 | 7,236 | 1.6 |
| Butylate ⁺ | 727 | 727 | 3,067 | 4.2 |
| Cyanazine | 1,783 | 1,808 | 3,105 | 1.7 |
| Dicamba | 1,030 | 1,030 | 327 | .3 |
| Propachlor | 667 | 667 | 1,562 | 2.3 |
| 2,4-D | 2,177 | 2,529 | 1,205 | .5 |
| Other | - | 1,218 | 3,127 | 2.6 |
| Total | - | 16,024 | 28,243 | 1.8 |
| <u>Tank-mix materials</u> | | | | |
| Atrazine + alachlor | 1,899 | 1,978 | 3,235+3,735 | 1.6+1.9 |
| Atrazine + butylate ⁺ | 250 | 250 | 369+745 | 1.5+3.0 |
| Atrazine + metolachlor | 517 | 528 | 814+982 | 1.5+1.9 |
| Atrazine + other <u>d/</u> | - | 549 | 633+1,271 | 1.2+2.3 |
| Cyanazine + alachlor | 410 | 410 | 714+858 | 1.7+2.1 |
| Cyanazine + other <u>e/</u> | - | 226 | 408+537 | 1.8+2.4 |
| Dicamba + 2,4-D | 570 | 614 | 178+210 | .3+ .3 |
| Other | - | 141 | 425 | 3.0 |
| Total | - | 4,696 | 15,114 | 3.2 |
| Total herbicides | - | 20,720 | 43,357 | 2.1 |
| INSECTICIDES | | | | |
| Carbofuran | 1,368 | 1,393 | 1,265 | .9 |
| Fonofos | 1,471 | 1,471 | 1,632 | 1.1 |
| Phorate | 1,150 | 1,150 | 1,301 | 1.1 |
| Terbufos | 1,201 | 1,201 | 1,328 | 1.1 |
| Other | - | 412 | 387 | .9 |
| Total | - | 5,627 | 5,913 | 1.1 |
| TOTAL PESTICIDES | - | 26,347 | 49,270 | 1.9 |

a/ "1980 Corn Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ Data in this column for "other" and "total" were not reported because two or more materials may have been used on the same acre resulting in multiple counting.

c/ Most farmers applied herbicides and insecticides one time during the growing season. The average number of applications per season for each material can be determined by dividing acre-treatments (column 2) by acres treated (column 1).

d/ Other includes cyanazine, dicamba, EPTC⁺, metolachlor, paraquat, pendimethalin, propachlor, simazine, and 2,4-D.

e/ Other includes butylate⁺, metolachlor, and simazine.

1.8, 1, and 2.5 million, respectively, or one-third of the single material herbicide acre-treatments. About 2 million (42 percent) of the herbicide mix acre-treatments were made with atrazine plus alachlor. Two-thirds of the alachlor and 37 percent of the cyanazine acre-treatments were made to control foxtail infestations (Appendix Table 2). Quackgrass was the primary target pest for two-thirds of the atrazine acre-treatments and cocklebur for 60 percent of the 2,4-D acre-treatments (Appendix Tables 2 and 3).

Approximately the same proportion of the insecticide acre-treatments was made with carbofuran, fonofos, phorate, and terbufos. These materials accounted for 5.2 million (93 percent) of the insecticide acre-treatments (Table 5). Approximately nine-tenths of the carbofuran, fonofos, and phorate acre-treatments and all of the terbufos acre-treatments were made for corn rootworm larvae control (Appendix Table 4). Also, 8 percent of the carbofuran acre-treatments and 10 percent of the phorate acre-treatments were made for European corn borer control.

MICHIGAN

Farmers in Michigan planted 3 million acres of field corn in 1980, of which 2.8 million were treated with herbicides and 1.4 million were treated with insecticides (Table 2). The total volume of field corn pesticides was 9.7 million pounds (a.i.), comprised of 3.9 million pounds of single material herbicides, 4.5 million pounds of herbicide mixes, and 1.3 million pounds of insecticides (Table 6). Single and combined material herbicides were applied at an average rate of 1.7 and 3.5 pounds (a.i.) per acre-treatment. Insecticide application rates averaged 1 pound (a.i.) per acre-treatment.

Approximately 4.9 million pesticide acre-treatments were made on field corn in 1980, which included 2.2 million with single material herbicides, 1.3 million

Table 6. Usage patterns and quantities of specific pesticides applied to field corn in Michigan, 1980 a/

| Pesticides | : Acres <u>b/</u> | : Acre- <u>c/</u> | Pounds of active ingredient | |
|---|-------------------|-------------------|-----------------------------|---------------|
| | : treated | : treatments: | Total | Per treatment |
| ----- <u>Thousand</u> ----- | | | | |
| HERBICIDES | | | | |
| <u>Single materials</u> | | | | |
| Alachlor | 342 | 342 | 593 | 1.7 |
| Atrazine | 1,139 | 1,167 | 2,336 | 2.0 |
| Cyanazine | 234 | 234 | 378 | 1.6 |
| Metolachlor | 137 | 137 | 189 | 1.4 |
| 2,4-D | 165 | 165 | 76 | .5 |
| Other | - | 176 | 312 | 1.8 |
| Total | - | 2,221 | 3,884 | 1.7 |
| <u>Tank-mix materials</u> | | | | |
| Atrazine + alachlor | 449 | 477 | 892+793 | 1.9+1.7 |
| Atrazine + butylate ⁺ | 110 | 110 | 162+272 | 1.5+2.5 |
| Atrazine + cyanazine | 69 | 69 | 107+54 | 1.6+ .8 |
| Atrazine + butylate ⁺ + cyanazine | 83 | 83 | 77+248+77 | .9+3.0+ .9 |
| Atrazine + metolachlor | 193 | 193 | 265+344 | 1.4+1.8 |
| Atrazine + other <u>d/</u> | - | 177 | 206+355 | 1.2+2.0 |
| Cyanazine + other <u>e/</u> | - | 164 | 268+331 | 1.6+2.0 |
| Other | - | 33 | 31+47 | .9+1.4 |
| Total | - | 1,306 | 4,529 | 3.5 |
| Total herbicides | - | 3,527 | 8,413 | 2.4 |
| INSECTICIDES | | | | |
| Carbofuran | 467 | 467 | 455 | 1.0 |
| Fonofos | 648 | 648 | 644 | 1.0 |
| Other | - | 234 | 236 | 1.0 |
| Total | - | 1,349 | 1,335 | 1.0 |
| TOTAL PESTICIDES | - | 4,876 | 9,748 | 2.0 |

a/ "1980 Corn Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ Data in this column for "other" and "total" were not reported because two or more materials may have been used on the same acre resulting in multiple counting.

c/ Most farmers applied herbicides and insecticides one time during the growing season. The average number of applications per season for each material can be determined by dividing acre-treatments (column 2) by acres treated (column 1).

d/ Other includes dicamba, paraquat, simazine, and 2,4-D.

e/ Other includes alachlor, butylate⁺, and metolachlor.

with herbicide mixes, and 1.3 million with insecticides.

Atrazine acre-treatments totaled 1.2 million (53 percent) of those made with single material herbicides. Alachlor and cyanazine accounted for 342,000 (15 percent) and 234,000 (11 percent), respectively, of the same set of acre-treatments. Atrazine plus alachlor accounted for 477,000 (37 percent) of the herbicide mix acre-treatments and atrazine plus metolachlor acre-treatments totaled 193,000 (15 percent).

The proportion of herbicide acre-treatments made to control the primary weed pests in Michigan was different than those in the other Lake States. A larger percentage of herbicide acre-treatments was made to control quackgrass infestations, whereas a smaller percentage was made for cocklebur and foxtail control (Table 3). Two-thirds of the alachlor acre-treatments were made to control foxtail and quackgrass infestations and 72 percent of the atrazine acre-treatments were made for quackgrass control (Appendix Table 2). Cocklebur, crabgrass, panicum, quackgrass, and ragweed control each accounted for between 12 to 24 percent of the cyanazine acre-treatments (Appendix Tables 2 and 3). An equivalent proportion of the 2,4-D acre-treatments, totaling 68 percent, was made to control cocklebur, morningglory, pigweed, and ragweed infestations.

About 467,000 (33 percent) of the insecticide acre-treatments were made with carbofuran and 648,000 (50 percent) were made with fonofos (Table 6). All of the fonofos and terbufos acre-treatments and 82 percent of the carbofuran acre-treatments were made to control corn rootworm larvae infestations (Appendix Table 4). Also, 18 percent of the carbofuran acre-treatments were made for European corn borer control.

MINNESOTA

Nearly 7.2 million acres of field corn were planted in Minnesota during 1980, while acres treated for weed and insect control totaled 6.9 and 1.7 million, respectively (Table 2). Of the 24.7 million pounds (a.i.) of pesticides applied to field corn, 17.6 million were single material herbicides, 5.3 million were herbicide mixes, and 1.8 million were insecticides (Table 7). The average application rates for herbicides, applied alone and in mixes, were 1.8 and 2.7 pounds (a.i.) per acre-treatment, respectively. Insecticide rates averaged 1.1 pounds (a.i.) per acre-treatment.

Pesticide acre-treatments totaled 13.5 million. About 9.9 million were made with single material herbicides, 1.9 million were made with herbicide mixes, and 1.7 million were made with insecticides.

About 4.7 million (48 percent) of the single material herbicide acre-treatments were made with either alachlor or 2,4-D. Atrazine and cyanazine acre-treatments totaled 1.4 and 1.1 million (14 and 11 percent), respectively. Atrazine plus alachlor acre-treatments totaled 654,000 (34 percent) of the herbicide mix acre-treatments and dicamba plus 2,4-D acre-treatments totaled 614,000 (32 percent).

A higher proportion of the herbicide acre-treatments was made to control cocklebur and foxtail infestations, whereas a lower proportion was made for quackgrass control in Minnesota than in the other Lake States (Table 3). Three-fourths of the alachlor acre-treatments were made for foxtail control and 63 percent of the atrazine acre-treatments were made to control quackgrass infestations (Appendix Table 2). Foxtail was the primary target pest for 46 percent of the cyanazine acre-treatments, while Canada thistle and pigweed control each accounted for 12 percent (Appendix Tables 2 and 3). Two-thirds of the 2,4-D acre-treatments were made to control cocklebur infestations.

Table 7. Usage patterns and quantities of specific pesticides applied to field corn in Minnesota, 1980 a/

| Pesticides | : Acres <u>b/</u> | : Acre- <u>c/</u> | : Pounds of active ingredient | |
|-----------------------------|-------------------|-------------------|-------------------------------|---------------|
| | : treated | : treatments | Total | Per treatment |
| ----- <u>Thousand</u> ----- | | | | |
| HERBICIDES | | | | |
| <u>Single materials</u> | | | | |
| Alachlor | 2,511 | 2,511 | 6,463 | 2.6 |
| Atrazine | 1,330 | 1,418 | 1,911 | 1.3 |
| Butylate ⁺ | 504 | 504 | 2,353 | 4.7 |
| Cyanazine | 1,124 | 1,124 | 2,024 | 1.8 |
| Dicamba | 835 | 835 | 270 | .3 |
| Propachlor | 615 | 615 | 1,459 | 2.4 |
| 2,4-D | 1,857 | 2,209 | 1,068 | .5 |
| Other | - | 703 | 2,096 | 3.0 |
| Total | - | 9,919 | 17,644 | 1.8 |
| <u>Tank-mix materials</u> | | | | |
| Alachlor + cyanazine | 356 | 356 | 777+632 | 2.2+1.8 |
| Atrazine + alachlor | 654 | 654 | 1,044+1,400 | 1.6+2.1 |
| Atrazine + other <u>d/</u> | - | 255 | 329+535 | 1.3+2.1 |
| Dicamba + 2,4-D | 570 | 614 | 178+210 | .3+ .3 |
| Other | - | 44 | 150 | 3.4 |
| Total | - | 1,923 | 5,255 | 2.7 |
| Total herbicides | - | 11,842 | 22,899 | 1.9 |
| INSECTICIDES | | | | |
| Carbofuran | 339 | 339 | 333 | 1.0 |
| Fonofos | 540 | 540 | 694 | 1.3 |
| Phorate | 352 | 352 | 335 | 1.0 |
| Terbufos | 395 | 395 | 415 | 1.1 |
| Other | - | 44 | 46 | 1.1 |
| Total | - | 1,670 | 1,823 | 1.1 |
| TOTAL PESTICIDES | - | 13,512 | 24,722 | 1.8 |

a/ "1980 Corn Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ Data in this column for "other" and "total" were not reported because two or more materials may have been used on the same acre resulting in multiple counting.

c/ Most farmers applied herbicides and insecticides one time during the growing season. The average number of applications per season for each material can be determined by dividing acre-treatments (column 2) by acres treated (column 1).

d/ Other includes cyanazine and metolachlor.

One-third (540,000) of the insecticide acre-treatments were made with fonofos, while carbofuran, phorate, and terbufos acre-treatments totaled 1.1 million (65 percent) (Table 7). Corn rootworm larvae were the primary target pest for all of the carbofuran and terbufos acre-treatments (Appendix Table 4). About 84 percent of the fonofos and 75 percent of the phorate acre-treatments were made for the same purpose. One-fourth of the phorate acre-treatments were made for European corn borer control.

WISCONSIN

About 4.2 million acres of field corn were planted during the 1980 growing season (Table 2). Of these, 4 million were treated with herbicides and 2.6 million were treated with insecticides. A total of 14.8 million pounds (a.i.) of pesticides were applied to field corn, consisting of 6.7 million pounds of single material herbicides, 5.3 million pounds of herbicide mixes, and 2.8 million pounds of insecticides (Table 8). An estimated 1.7 pounds (a.i.) of single material herbicides and 3.6 pounds (a.i.) of herbicide mixes were applied per acre-treatment. Insecticides were applied at a rate of 1.1 pounds (a.i.) per acre-treatment.

Pesticide acre-treatments totaled 8 million, comprised of 3.9 million with single material herbicides, 1.5 million with herbicide mixes, and 2.6 million with insecticides.

One-half (1.9 million) of the single material herbicide acre-treatments were made with atrazine. Alachlor and cyanazine acre-treatments totaled 721,000 (19 percent) and 451,000 (12 percent), respectively. Atrazine plus alachlor acre-treatments accounted for 847,000 (58 percent) of those made with herbicide mixes.

The proportion of pesticide acre-treatments made for quackgrass and

Table 8. Usage patterns and quantities of specific pesticides applied to field corn in Wisconsin, 1980 a/

| Pesticides | : Acres <u>b/</u> | : Acre- <u>c/</u> | : Pounds of active ingredient | |
|-----------------------------|-------------------|-------------------|-------------------------------|---------------|
| | : treated | : treatments | Total | Per treatment |
| ----- <u>Thousand</u> ----- | | | | |
| HERBICIDES | | | | |
| <u>Single materials</u> | | | | |
| Alachlor | 721 | 721 | 1,558 | 2.2 |
| Atrazine | 1,871 | 1,886 | 2,989 | 1.6 |
| Butylate ⁺ | 167 | 167 | 529 | 3.2 |
| Cyanazine | 425 | 451 | 703 | 1.6 |
| 2,4-D | 155 | 155 | 61 | .4 |
| Other | - | 503 | 875 | 1.7 |
| Total | - | 3,883 | 6,715 | 1.7 |
| <u>Tank-mix materials</u> | | | | |
| Atrazine + alachlor | 796 | 847 | 1,299+1,541 | 1.5+1.8 |
| Atrazine + metolachlor | 170 | 180 | 384+401 | 2.1+2.2 |
| Atrazine + other <u>d/</u> | - | 260 | 285+710 | 1.1+2.7 |
| Cyanazine + other <u>e/</u> | - | 116 | 222+286 | 1.9+2.5 |
| Other | - | 64 | 196 | 3.1 |
| Total | - | 1,467 | 5,324 | 3.6 |
| Total herbicides | - | 5,350 | 12,039 | 2.3 |
| INSECTICIDES | | | | |
| Carbofuran | 562 | 587 | 476 | .8 |
| Fonofos | 283 | 283 | 294 | 1.0 |
| Phorate | 799 | 799 | 966 | 1.2 |
| Terbufos | 737 | 737 | 846 | 1.1 |
| Other | - | 203 | 171 | .8 |
| Total | - | 2,609 | 2,753 | 1.1 |
| TOTAL PESTICIDES | - | 7,959 | 14,792 | 1.9 |

a/ "1980 Corn Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ Data in this column for "other" and "total" were not reported because two or more materials may have been used on the same acre resulting in multiple counting.

c/ Most farmers applied herbicides and insecticides one time during the growing season. The average number of applications per season for each material can be determined by dividing acre-treatments (column 2) by acres treated (column 1).

d/ Other includes butylate⁺, cyanazine, dicamba, EPTC⁺, pendimethalin, propachlor, and simazine.

e/ Other includes butylate⁺ and simazine.

velvetleaf control was higher in Wisconsin than in the region as a whole, whereas the proportion of herbicide acre-treatments made for cocklebur and foxtail control was lower (Table 3). About 54 percent of the alachlor acre-treatments were made to control foxtail infestations and two-thirds of the atrazine acre-treatments were made for quackgrass control (Appendix Table 2). One-third of the cyanazine acre-treatments were made for foxtail control and 29 percent were made to control velvetleaf infestations (Appendix Tables 2 and 3). Velvetleaf was the primary target pest for 83 percent of the 2,4-D acre-treatments, while Canada thistle control accounted for 17 percent.

Insecticide acre-treatments totaled 587,000 (22 percent) with carbofuran, 283,000 (11 percent) with fonofos, 799,000 (31 percent) with phorate, and 737,000 (28 percent) with terbufos (Table 8). All of the terbufos was used for corn rootworm larvae control (Appendix Table 4). Also, between 91 and 96 percent of the carbofuran, fonofos, and phorate acre-treatments were made for the same purpose.

REFERENCES

1. Delvo, Herman W., "1972 Corn Objective Yield Survey", USDA, ERS, Farm Production Economics Division, 1972, (unpublished).
2. U.S. Department of Agriculture, "Agricultural Statistics, 1974".
3. USDA, ESS, Crop Reporting Board, "Crop Production-1980 Annual Summary", CrPr 2-1(81), January 14, 1981.
4. USDA, ESS, Crop Reporting Board, "Field Crops-Production, Disposition, Value 1979-80", CrPr 1(81), April 1981.

Appendix Table 1. Coefficients of variation for acres of field corn treated with specific pesticides in the Lake States, 1980 a/ b/

| Pesticides | : | : | : | : |
|----------------------------------|----------------|-------------|-------------|----------|
| | : Michigan | : Minnesota | : Wisconsin | : Region |
| | <u>Percent</u> | | | |
| HERBICIDES | | | | |
| <u>Single materials</u> | | | | |
| Alachlor | 26 | 11 | 17 | 9 |
| Atrazine | 12 | 16 | 9 | 7 |
| Butylate ⁺ | 70 | 28 | 38 | 22 |
| Cyanazine | 33 | 18 | 22 | 13 |
| Dicamba | 61 | 22 | 44 | 19 |
| Propachlor | - | 26 | 70 | 24 |
| 2,4-D | 40 | 13 | 40 | 12 |
| <u>Tank-mix materials</u> | | | | |
| Atrazine + alachlor | 22 | 25 | 16 | 12 |
| Atrazine + butylate ⁺ | 49 | 70 | 70 | 36 |
| Atrazine + metolachlor | 37 | 51 | 36 | 23 |
| Cyanazine + alachlor | 61 | 34 | - | 31 |
| Dicamba + 2,4-D | - | 27 | - | 27 |
| INSECTICIDES | | | | |
| Carbofuran | 22 | 35 | 19 | 14 |
| Fonofos | 18 | 27 | 29 | 14 |
| Phorate | - | 35 | 16 | 15 |
| Terbufos | 59 | 33 | 17 | 15 |

- None reported.

a/ "1980 Corn Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ A coefficient of variation is the standard error of the estimate divided by acres treated times 100. A coefficient of variation describes the relative variation or precision of the estimate. The lower the value of the coefficient, the more precise the estimate.

Appendix Table 2. Percentage of field corn herbicide acre-treatments by primary grasses controlled as reported by farmers in the Lake States, 1980 a/

| Herbicides, grasses | : | : | : | : | |
|-----------------------|----------------|-------------|-------------|----------|--|
| | : Michigan | : Minnesota | : Wisconsin | : Region | |
| | <u>Percent</u> | | | | |
| <u>Alachlor</u> | | | | | |
| Crabgrass | 12 | - | - | 1 | |
| Foxtail | 40 | 75 | 54 | 68 | |
| Johnsongrass | 8 | - | - | 1 | |
| Panicum | 8 | - | 7 | 2 | |
| Quackgrass | 24 | 9 | 14 | 11 | |
| Other | - | 9 | 7 | 8 | |
| <u>Atrazine</u> | | | | | |
| Broadleaf signalgrass | 2 | - | 1 | 1 | |
| Crabgrass | 2 | - | - | 1 | |
| Foxtail | 7 | 9 | 12 | 10 | |
| Quackgrass | 72 | 63 | 67 | 67 | |
| Other | 10 | 7 | 7 | 7 | |
| <u>Cyanazine</u> | | | | | |
| Barnyardgrass | - | 4 | - | 2 | |
| Crabgrass | 17 | - | 6 | 4 | |
| Foxtail | - | 46 | 34 | 37 | |
| Johnsongrass | - | - | 17 | 4 | |
| Panicum | 24 | - | 6 | 5 | |
| Quackgrass | 12 | 8 | 3 | 7 | |
| Other | 12 | 3 | 5 | 4 | |

- None reported.

a/ "1980 Corn Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

Appendix Table 3. Percentage of field corn herbicide acre-treatments by primary broadleaf weeds controlled as reported by farmers in the Lake States, 1980 a/

| Herbicides, broadleaf weeds | : | : | : | : |
|-----------------------------|---------------------|-----------|-----------|--------|
| | Michigan | Minnesota | Wisconsin | Region |
| | ----- Percent ----- | | | |
| <u>Alachlor</u> | | | | |
| Cocklebur | - | - | 7 | 1 |
| Pigweed | - | 2 | - | 1 |
| Ragweed | - | 2 | - | 1 |
| Smartweed | - | - | 4 | 1 |
| Velvetleaf | 8 | - | 7 | 2 |
| Other | - | 3 | - | 3 |
| <u>Atrazine</u> | | | | |
| Canada thistle | - | 3 | - | 1 |
| Cocklebur | - | - | 1 | 1 |
| Pigweed | 2 | - | 1 | 1 |
| Ragweed | 5 | 9 | 3 | 5 |
| Velvetleaf | - | 9 | 8 | 6 |
| <u>Cyanazine</u> | | | | |
| Canada thistle | - | 12 | - | 7 |
| Cocklebur | 12 | 4 | - | 4 |
| Morningglory | - | 4 | - | 2 |
| Pigweed | - | 12 | - | 7 |
| Ragweed | 12 | 4 | - | 4 |
| Velvetleaf | - | - | 29 | 7 |
| Other | 11 | 3 | - | 6 |
| <u>2,4-D</u> | | | | |
| Canada thistle | - | 15 | 17 | 14 |
| Cocklebur | 17 | 67 | - | 60 |
| Morningglory | 17 | 2 | - | 3 |
| Pigweed | 17 | 8 | - | 8 |
| Ragweed | 17 | - | - | 1 |
| Smartweed | - | 2 | - | 2 |
| Velvetleaf | - | - | 83 | 5 |
| Other | 32 | 6 | - | 7 |

- None reported.

a/ "1980 Corn Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

Appendix Table 4. Percentage of field corn insecticide acre-treatments by primary insects controlled as reported by farmers in the Lake States, 1980 a/

| Insecticides, insects | : | : | : | : |
|-----------------------|----------------|-------------|-------------|----------|
| | : Michigan | : Minnesota | : Wisconsin | : Region |
| | <u>Percent</u> | | | |
| <u>Carbofuran</u> | | | | |
| Corn rootworm larvae | 82 | 100 | 96 | 92 |
| European corn borer | 18 | - | 4 | 8 |
| <u>Fonofos</u> | | | | |
| Corn rootworm larvae | 100 | 84 | 91 | 92 |
| European corn borer | - | 8 | - | 3 |
| Grubs | - | - | 9 | 2 |
| Wireworm | - | 8 | - | 3 |
| <u>Phorate</u> | | | | |
| Corn rootworm larvae | - | 75 | 94 | 88 |
| European corn borer | - | 25 | 3 | 10 |
| Wireworm | - | - | 3 | 2 |
| <u>Terbufos</u> | | | | |
| Corn rootworm larvae | 100 | 100 | 100 | 100 |

- None reported.

a/ "1980 Corn Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

